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Aspects of the Demand for Migratory Game Bird Hunting Licences in Alberta

Socioeconomic Occasional Paper Number 3

Alberta

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ASPECTS OF THE DEMAND FOR MIGRATORY GAME BIRD HUNTING LICENCES IN ALBERTA.

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Number 3

BY:

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EXECUTIVE SUMMARY

This study uses economic theory to investigate aspects of the demand for migratory game bird hunting licences in Alberta. Demand is defined as the observed number of federal migratory bird licences sold to Albertans in a given year. Although many people who did not purchase licences would still like to hunt, their decision not to buy a licence was influenced by licence prices, the supply of birds available, and the time and weather. This paper investigates the significance of the relationship between some of these factors and licence sales in Alberta.

First, the hypothesis was tested that price is a significant factor in the demand for licences. Price consisted of the sum of the following licence costs: an Alberta Wildlife Certificate, an Alberta Game Bird Stamp, and a Federal Migratory Game Bird Permit. These prices were determined for the years 1968 to 1986, and were then corrected for inflation by converting them each year to 1981 dollars using the Consumer Price Index. Other variables were included with price in two multiple regression models. These included the following: indicators of the supply of birds, harvest success, waterfowl breeding habitat, agricultural factors, fall weather, per capita income (corrected for inflation), and provincial population. The following formulae summarize the results of two possible models identified by the statistical analyses:

$$NOLIC = 117.48 - 3.27PRICE + 0.03HARVLAG - 0.01PONDS - 0.07PRECIP - 0.53TREND$$

$$\ln(NOLIC) = 4.98 - 0.49PRICE + 0.0005HARVLAG - 0.0002PONDS - 0.0015PRECIP - 0.009TREND$$

Where: NOLIC is the number of federal licences sold in a year (in 1000s);

PRICE is the sum of the prices of the three required permits to hunt birds in Alberta corrected for inflation (in 1981 dollars);

HARVLAG is the total number of ducks and geese harvested in Alberta in the previous year (in 1000s);

PONDS is the May pond index for standing water in Alberta;

PRECIP is the total precipitation that fell in September and October in defined areas of Alberta; and

TREND is a variable that accounts for omitted variables such as tastes and preferences of hunters.

All these variables were statistically significant. Licence price, fall precipitation, and the condition of the spring breeding habitat for ducks had a negative effect on the number of licences purchased. This is interpreted as meaning that price is a significant factor in predicting the sale of migratory game bird hunting licences. As the price rises, the number of licences sold falls.

Since part of licence revenue is allocated to some management and habitat programs, the actual price charged is of some concern. The revenue maximizing price was determined for 1986 using the models shown above. In 1986, it actually cost $23.50 to hunt migratory game birds. Revenue maximizing prices were estimated to be $20.62 for the linear model and $25.98 for the semi-log model. Based on the model used, these results indicate that if revenue maximization is a concern, the licence

fee should probably not be raised in the future. A higher price will cause more hunters to stop participating by not purchasing licences. A lower licence price may even increase revenue by encouraging more hunters to buy permits at the lower fee.

Finally, this study investigated the effect of the stabilized duck hunting regulations (in effect from 1979 to 1984) on the demand for licences. This investigation showed that the regulation stabilization program had a positive effect on the demand for licences. This effect was perhaps related to hunters' knowledge that wildlife management agencies were doing something about the declining populations of waterfowl. Regulations are one visible indicator of an agency's willingness to address a specific management problem. However, the analysis on this aspect was not comprehensive. Therefore the positive effect may be the result of other factors that influenced demand during the same time period.

The idea that licence price is an important factor in determining hunter numbers seems to be relatively new to most wildlife managers. It also seems to be true of bird hunters but not necessarily big game hunters in Alberta. The reason for this could be that licence price is a more significant portion of the total cost of hunting birds than hunting big game. To illustrate this, in 1981 the average Alberta waterfowl hunter spent $483.91 during the season. Bird licence fees totalled $18.50, about 4% of the total expenditures. Big game hunters spent $864.31 during the 1981 season and only $20.00 for fees to hunt one species, about 2% of their total expenditures. In addition, although licence fees may be treated as a consumer product, they may be viewed differently by individuals because they involve the purchase of a right to do something, not a good that is "consumed".

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This study was originally intended to provide input into programs investigating financial compensation to farmers as a result of waterfowl depredation. During this time, Anita Duarte-Pedrosa conducted research into hunting demand which provided much baseline information. Following this, Mark Anielski of the Alberta Forest Service expanded the analysis for a research paper during his studies at the University of Alberta. The work of both of these individuals contributed greatly to the present study and I offer thanks for their support and guidance.

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1. INTRODUCTION

> "The theory of economics does not furnish a body of settled conclusions immediately applicable to policy. It is a method rather than a doctrine, an apparatus of mind, a technique of thinking which helps its possessor to draw conclusions."
> [from A. Takayama 1972]

This quote by Takayama should temper the concern which arises from viewing hunting as a consumer product. It must be recognized that, for the vast majority of participants hunting is a form of leisure or recreation. As such, it competes with other forms of recreation and is suffering a serious reduction in participation in Alberta. This can be attributed to many economic, sociological and biological variables. Consumer demand theory is a useful tool in the studying the changing pattern of resource supply, the demand for hunting, and the relationships between the many other possible explanatory variables.

A. MIGRATORY GAME BIRD HUNTING IN ALBERTA

Alberta is well-known for the quality of waterfowl hunting which is due to the agricultural landscape and sizeable populations of birds. These factors undoubtedly influence, in both economic and sociological terms, the number of resident Albertans who hunt in a given year.

Migratory game bird licence sales have varied from about 53 600 in 1968 to 45 000 in 1986, with a peak value of 82 200 in 1980. However,

a distinct pattern in sales exists (Figure 1a). Numbers rose steadily from 1968 to 1977, remained fairly constant from 1977 to 1980, and since then have declined dramatically. The number of licences sold in Alberta during 1986 was approximately 45 000.

One important factor that could have influenced the decline in waterfowl licence sales is the number of ducks. The prairie provinces contain some of the most productive breeding habitat for ducks in North America. Due in part to dry weather during certain periods, changing agricultural practices and wetland drainage, this habitat is changing. Consequently, duck numbers have been declining since the late 1970s. This is illustrated in Figure 1c which plots the May breeding index for total ducks in Alberta against time. This decline is of concern to waterfowl managers. Numerous management programs and research efforts have tried to identify other factors which may have contributed to the duck population decline. Hunting regulations have been adjusted and stabilized by managers for certain periods of time to investigate the effects of hunting on duck populations.

If participation in waterfowl hunting is linked, at least in part, to economic factors, then the real price of a licence should be related inversely to numbers of licences sold. The "real" price represents the prices of licences adjusted for inflation. This is done by expressing prices in the years under study (here 1968-1986) in constant 1981 dollars. Figure 1b shows that an inverse relationship does exist. When licence sales were highest (1977), the price of a hunting licence was close to its lowest cost (Figure 1a). Overall, the maximum

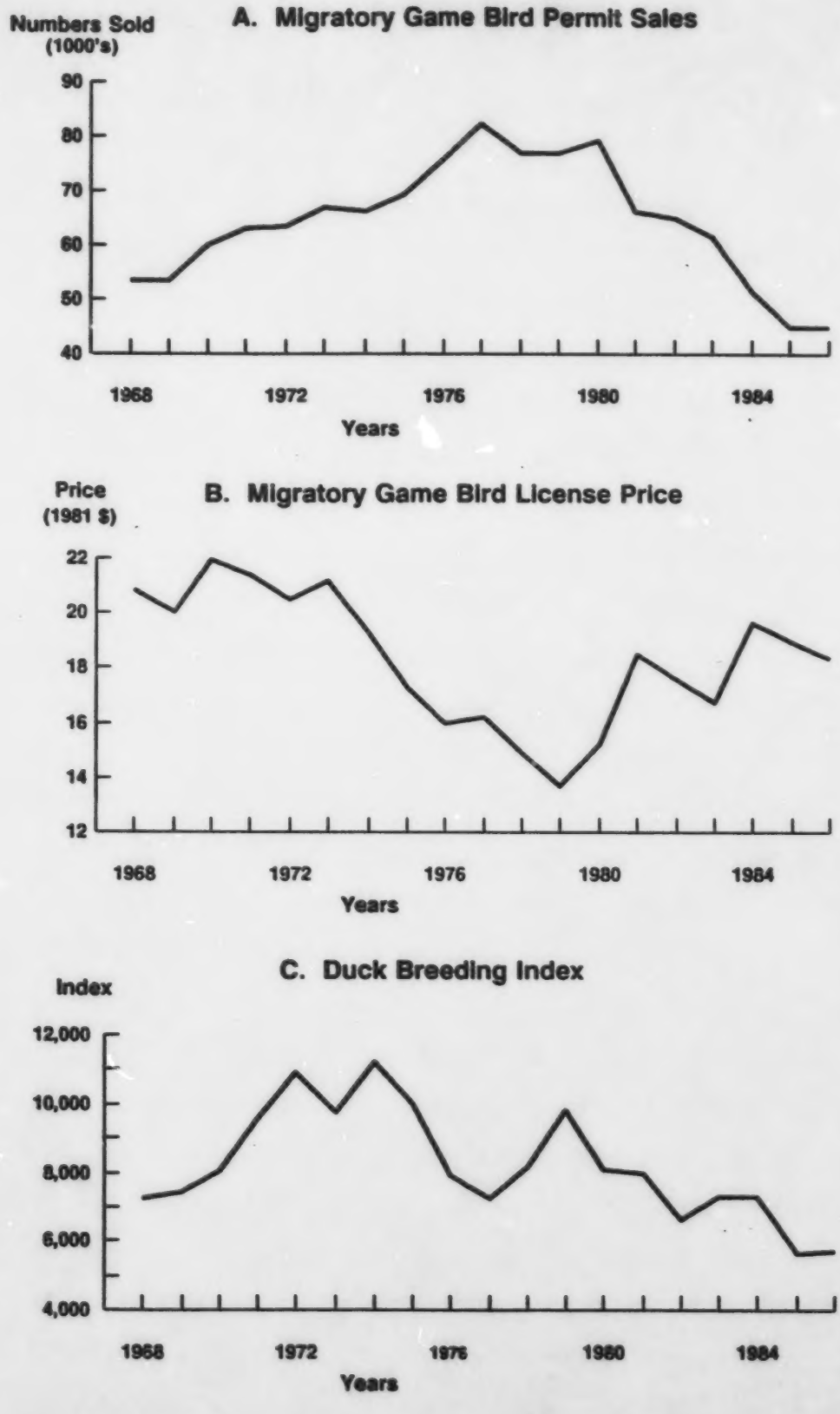


Figure 1. Historical Trends in Sales of Migratory Game Bird Hunting Permits, License Price and Duck Breeding Indices in Alberta from 1968 to 1986.

cost of the licence sale curve is close to the minimum of the price curve.

In this paper, economic theory is applied to these relationships to investigate three questions relating to the demand for migratory game bird hunting in Alberta. These are:

1) **Do economic variables play a significant role in the demand for migratory game bird licences?**

Statements made by many managers have indicated to the author that the price of a licence is not thought to be a significant factor in hunting participation. Licence fees have actually been raised or proposed with only secondary consideration given to declining participation which may result from these changes (eg. Young and Wrobel 1985). In fact, declining licence sales resulting from increases in price seems to have occurred in Alberta (Figure 2), and comments by some hunters on socio-economic surveys indicate some concern about licence fees and how these funds are used (personal observation and results of British Columbia study [Province of British Columbia 1987]).

These observations, together with the North American philosophy that hunting participation should not be limited by personal income, have led to some interesting questions. The licence price has been a small portion of the total cost of hunting in a year. Is it now high enough to be considered a major expense? Is the licence fee considered to be a different kind of economic variable by hunters because the money goes directly to the government? These questions can be investigated only by first determining if standard economic variables, such as price, actually influence hunting demand.

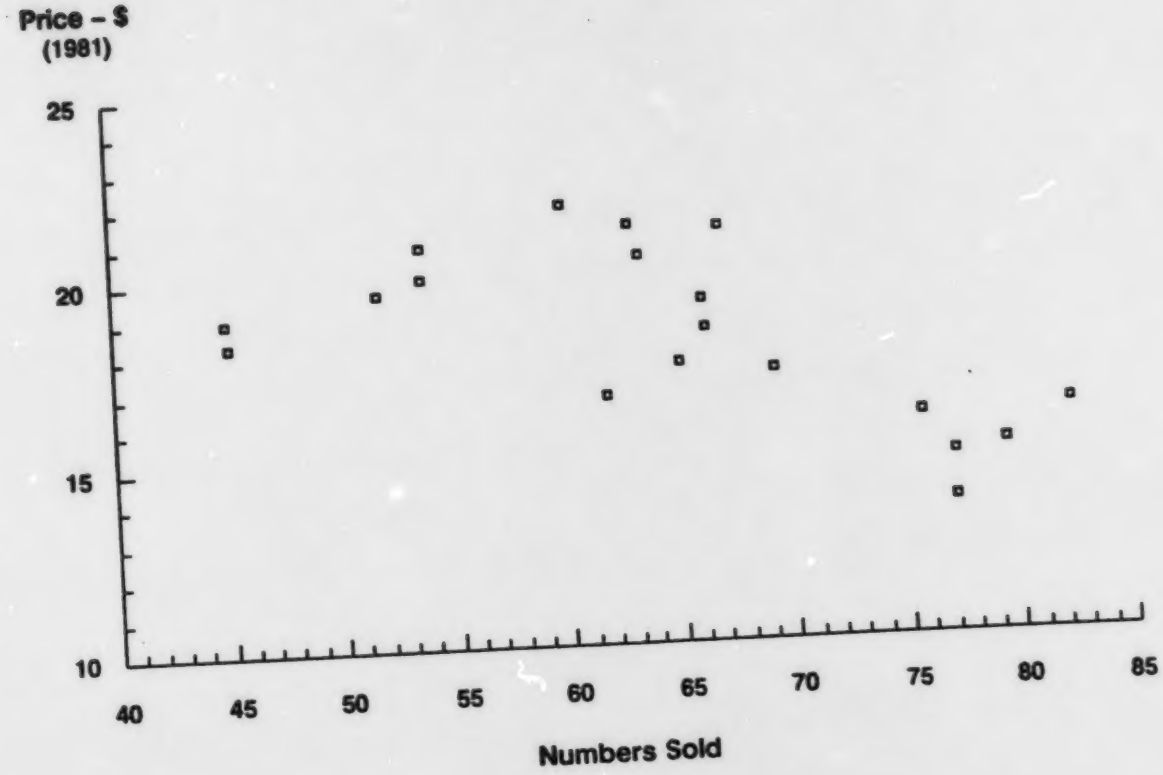


Figure 2. A Plot of Migratory Game Bird Hunting Permit Sales (1000's) Against Real Price (1981 dollars).

2) **What is the revenue maximizing fee for a migratory game bird licence?**

Licence revenues are used by many North American jurisdictions to fund wildlife management programs. Although these programs are funded from general government revenues in Alberta, the recent economic conditions have raised concern about government revenue keeping up with the need for changing resource use and optimum management. Licence revenue is one possible source of funds. As an example, proposals have been put forward to compensate Alberta farmers for wildlife depredation on grains and feeds. Licence revenues are being viewed as a source of funds for compensation.

These factors have put pressure on raising hunting licence fees. However, economic theory predicts that declining demand would be the result. Since revenue equals price multiplied by quantity demanded, there will be a price at which revenue is maximized. The determination of this price for migratory waterfowl hunting licences in Alberta will serve to illustrate how price affects demand, and what the maximum revenue from this source could be.

3) **What effect has the stabilized duck hunting regulations program (1979-1984) had on the demand for hunting licences?**

The change in duck numbers in North America prompted managers to stabilize the bag limits so the relationship between hunting mortality and the decline in duck populations could be investigated. The program involved a number of jurisdictions and continued for a five-year period, 1979 to 1984. Although numerous studies have investigated the effect of the regulation on the waterfowl, very few have examined its effects on the hunters.

B. OUTLINE OF CONSUMER DEMAND THEORY

Economic theory has much to offer the realm of recreational hunting. For example, legal participation in hunting requires the purchase of a licence or permit. These licences are similar to many other consumer products or goods. Different forms of hunting require different licences which are available at varying prices. Hunters will purchase a licence if they feel its value to them is equal to or greater than its price. Thus, the price of a licence probably has an influence on participation in hunting.

Economic theory suggests that the demand for any good or service available in the marketplace is influenced by at least five elements: (1) the price charged for the good or service; (2) the number of available buyers or consumers; (3) the income of consumers; (4) the prices of substitute or complementary products; and (5) the tastes and preferences of consumers (Call and Holahan 1983:6-9). These variables together form a demand equation:

$$Q_d = f(P, P^C, P^S, I, N, T)$$

where:

Q_d = the quantity demanded of the good

P = the price of the good

P^C = prices of complementary goods

P^S = prices of substitute goods

I = consumer income

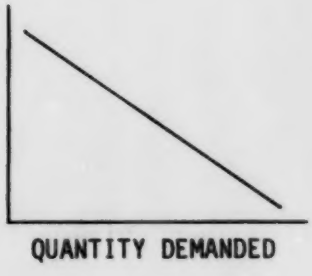
N = the number of potential consumers

T = tastes and preferences of consumers.

Other factors also affect the demand for a good, including fads, information about substitutes, regulations, customs, and other social changes. However, it is important to note that most of the explanatory factors, except price, are beyond the control of those providing the good or service.

Although demand is a multi-dimensional relationship between quantity consumed and factors that determine how much is consumed, a simple diagrammatic representation of the demand equation is commonly used. This is the demand curve. Essentially, the determinants of demand are divided into two groups: a movement parameter and shift parameters. Since the price of the good is the only variable controlled by those offering the good, it is the movement parameter. All other variables in the demand function are shift parameters. Thus, the demand curve shows the unidimensional relationship between price and quantity demanded; the other variables operate to shift the curve to the right (increase in demand) or the left (decrease in demand).

e.g.



For most goods, as the price increases the quantity demanded decreases. This is shown in the above example by a line with a negative slope.

The sensitivity of the quantity demanded to changes in price is defined as the elasticity of demand. The demand for a good is said to be

inelastic when the quantity demanded is less responsive to changes in price. Alternatively, when the quantity demanded is more responsive to changes in the price of the good, it is said to be elastic. Unitary elasticity is where the quantity demanded changes proportionally with price. This particular aspect of economic theory is useful in predicting changes in revenue when changes in the price of a good occur.

2. METHODS

In order to apply economic theory to quantitatively study the demand for migratory game bird licences, a mathematical model is specified. This model includes as many explanatory variables as possible given the limitations of the information. Once the variables were specified, least squares multiple regression procedures were used to specify the exact nature of the model. In this paper, the variable specifying the demand for licences is the number of licences sold in Alberta during a calendar year. Since this unit of demand incorporates an element of time (year), these data represent a time-series data set.

There are numerous, potential explanatory variables that can be used in a demand function for migratory bird licences. In addition to economic variables, biological variables such as the numbers of available birds to hunt, species composition of the flocks, breeding indices, and habitat conditions are potentially influential on the demand for hunting. Factors such as fall weather and agricultural practices and conditions may also be significant. Sociological indicators like hunting success, expectations, crowding, and knowledge of waterfowl populations may influence demand. Finally, the costs of other goods and services involved in hunting are likely to affect the demand for licences.

The following independent variables were used in this study:

PRICE = Price in dollars of purchasing all licences required to hunt migratory game birds in Alberta. These included an Alberta Wildlife Certificate, a

Provincial Game Bird Stamp, and a Federal Migratory Game Bird Permit. All prices were adjusted for inflation using the Consumer Price Index (CPI) for Alberta (1981 = 100). This adjusted price is called Real Price.

POP = Population of Alberta over 15 years of age. This provides an estimate of the numbers of potential hunters given maximum participation. Units used were thousands.

INCOME = Income per capita of Alberta residents adjusted for inflation using the CPI for Alberta (1981 = $1.00).

WFDLAG = The total number of days spent waterfowl hunting in Alberta in the previous year. These data came from the Canadian Wildlife Service's Migratory Game Bird Hunter Survey. This variable was included to provide an indication of the influence of prior committment to hunting. Units used were thousands.

HARVLAG = The total number of ducks and geese harvested by hunters in the previous year. This came from the federal survey and was included to provide some measure of expectations about the hunting experience based upon previous experience. Units used were thousands.

PONDS = An index measuring the number and conditions of the breeding habitat available in Alberta for resident ducks. In discussions with game bird biologists, it was determined that these indices are publicized prior to the hunting season. This variable was included to measure the influence this knowledge may have on hunting demand.

BREED and BREEDLAG = These indices measure the breeding success of Alberta ducks in the current and previous years.

PRECIP = The average of the total amount of precipitation which fell in Edmonton, Calgary, Peace River, Red Deer, and Lethbridge during September and October. This variable was included for its possible influence on hunter participation, and its effect on agricultural conditions through the fall.

CROPS = The number of days between swathing and combining grain crops. Ducks are known to depredate crops left in swaths in the fields. The time available for this depredation to occur was included because of its possible influence on the availability of ducks for hunters.

TREND = A trend variable was included in the model to pick up the effect of omitted variables such as tastes or preferences. Since this study is a time series

analysis, autocorrelation could be a problem. Introducing a trend variable reduces this possibility. Using trend variables do not increase the explanatory power of the model, however. The actual values were 1 for 1968, 2 for 1969, and up to 19 for 1986.

Some potential influential variables were not included (e.g. the costs of hunting aside from purchasing licences). The reason for this is the lack of available information for each of the years under investigation.

In any study involving demand estimation, the exact functional form of the regression model is a concern. Generally, the functional form becomes particularly important in benefit or consumer surplus estimation because the area under the demand curve is calculated. It is also significant if the demand equation is used to predict use or demand in the future. However, in this study the specification of the model is probably only significant in terms of determining a revenue maximizing price. Thus, only two functional forms were estimated: a linear form [1] and a semi-log form [2]:

$$NOLIC = B_0 - B_1PRICE + B_2POP + B_3INCOME - B_4PRECIP + B_5 \cdots B_n \text{ (all other variables)} + E \quad [1]$$

$$\ln (NOLIC) = B_0 - B_1PRICE + B_2POP + B_3INCOME - B_4PRECIP + B_5 \cdots B_n \text{ (all other variables)} + E \quad [2]$$

Negative signs were expected on the PRICE coefficients in accordance with economic theory, and on the PRECIP coefficients as hunters may not purchase licences because of inclement weather. All other coefficients were anticipated to be positive due to their positive effect on the demand for hunting licences.

3. RESULTS

A. SPECIFICATION OF THE DEMAND FUNCTION

Statistical analyses were conducted using Ordinary Least Squares (OLS) procedures in SAS and SHAZAM. Possible violations of the assumptions of OLS regression theory were investigated (Johnson et al. 1987). Multicollinearity between explanatory variables was detected through an inspection of correlation matrices between variables and by calculating variance inflation factors (VIF). A VIF greater than 10 was initially selected as the criterion for identifying multicollinearity. Heteroscedasticity, which describes the case of nonconstant variance in the disturbance term (E in equation [1]), was investigated through an examination of plots of residuals against each independent variable. Autocorrelation was detected by calculating Durbin Watson statistics and determining their significance.

Table 1 summarizes the results of the regression analyses. Stepwise regression procedures using forward selection initially identified the following variables (in order of contribution to R^2) as influential in describing hunting demand: HARVLAG, PRICE, TREND, PONDS, PRECIP and BREEDLAG. Coefficients were statistically significant ($P<0.10$) for all variables except BREEDLAG. HARVLAG had a positive effect on demand, while all other variables had a negative influence.

Table 1

Estimated Demand Equations for Migratory Game Bird Hunting Licenses in Alberta[1]

Dependent Variable	Constant	PRICE	HARVLAG	PONDS	PRECIP	BREEDLAG	TREND	$\bar{R}^2$	F VALUE
1. NOLIC	111.890 (8.814)**	-3.2420 (-7.553)**	0.0299 (4.516)**	-0.0097 (-4.240)**	-0.0623 (-1.857)*	0.0007 (0.784)NS	-0.4957 (-2.425)**	0.898	27.56 **
2. NOLIC	116.0400 (10.210)**	-3.2400 (-7.714)**	0.0322 (5.435)**	0.0089 (-3.075)**	-0.0665 (-2.044)*	—	-0.5198 (-2.611)**	0.902	33.96 **
3. NOLIC[2]	117.4800 (10.569)**	-3.2665 (-8.772)**	0.0323 (5.637)**	-0.0094 (-3.451)**	-0.0731 (-2.304)**	—	-0.5321 (-3.021)**	—	—
4. ln(NOLIC)	4.9554 (26.169)**	-0.0490 (-7.004)**	0.0005 (5.231)**	-0.0002 (-3.049)**	-0.0014 (2.514)**	—	-0.0088 (-2.665)**	0.895	31.95 **
5. ln(NOLIC)^2	4.9834 (28.042)**	-0.0493 (-7.839)**	0.0005 (5.344)**	-0.0002 (-3.431)**	-0.0015 (-2.870)**	—	-0.0090 (-3.015)**	0.898	32.69 **

[1]Numbers in parentheses below each coefficient is the t statistic associated with H_0:/coefficient/ = 0

* P<0.10

** P<0.05

NS not significant

[2]The coefficients portrayed here are corrected for autocorrelation by using the Cochrane-Orcutt iterative procedure in SHAZAM

This was anticipated for PRICE and PRECIP but not for PONDS. The negative sign on the TREND coefficient was due to the overall negative pattern of licence sales over time (Figure 1).

Two other regression equations were estimated after the initial explanatory variables were identified (Table 1). The first included all identified independent variables except BREEDLAG. The F ratio for this regression was 33.96 and is significant at the 99% level for the linear model. The semi-log model had a similarly significant F ratio. The adjusted R^2 for either model was over 0.89. All coefficients were significantly different than 0 ($P<0.05$). Due to the increase in the R^2 and F ratio following the exclusion of BREEDLAG, the equations with the other five variables were chosen as final demand equations given the information used in the estimation procedures.

Heteroscedasticity was not identified through examination of residual plots. Multicollinearity was not suspected through examination of a correlation matrix (Table 2) and with the VIF described above. However, the Durbin Watson statistic associated with the linear model was 2.1669 and was 2.069 for the semi-log form. Both of these values lie in the inconclusive range for identifying autocorrelation. Since the existence of autocorrelation causes a bias in the variances of the coefficients, un-autocorrelated models were specified.[1] This was done by using Cochrane-Orcutt iterative procedures in SHAZAM. The corrected linear and semi-log equations, (Table 1) were as follows:

---

[1]The problem is that the error term of the model at time x is a function of previous error terms - here time x-1 or first order autocorrelation. The demand equation must be estimated such that the error terms are non-autocorrelated (see Kennedy 1987 for a complete description of this procedure).

Table 2

Pearson Correlation Coefficients Between Influential Variables Identified by Stepwise Regression Analyses

	NOLIC	PRICE	HARVLAG	PONDS	PRECIP	BREEDLAG	TREND
NOLIC		-0.63*	-0.67*	0.14	-0.55*	0.48*	-0.13
PRICE			-0.03	0.06	0.11	0.02	-0.50*
HARVLAG				0.52*	-0.57*	0.70*	-0.44*
PONDS					-0.42	0.57*	-0.31
PRECIP						0.53*	0.29
BREEDLAG							-0.42

* indicates a correlation coefficient significantly different than 0 at $P<0.05$.

$$NOLIC = 117.48 - 3.2665PRICE + 0.0323HARVLAG - 0.0094PONDS - 0.0731PRECIP - 0.5321TREND + E \quad [3]$$

$$\ln(NOLIC) = 4.98 - 0.0493PRICE + 0.0005HARVLAG - 0.0002PONDS - 0.0015PRECIP - 0.0090TREND + E \quad [4]$$

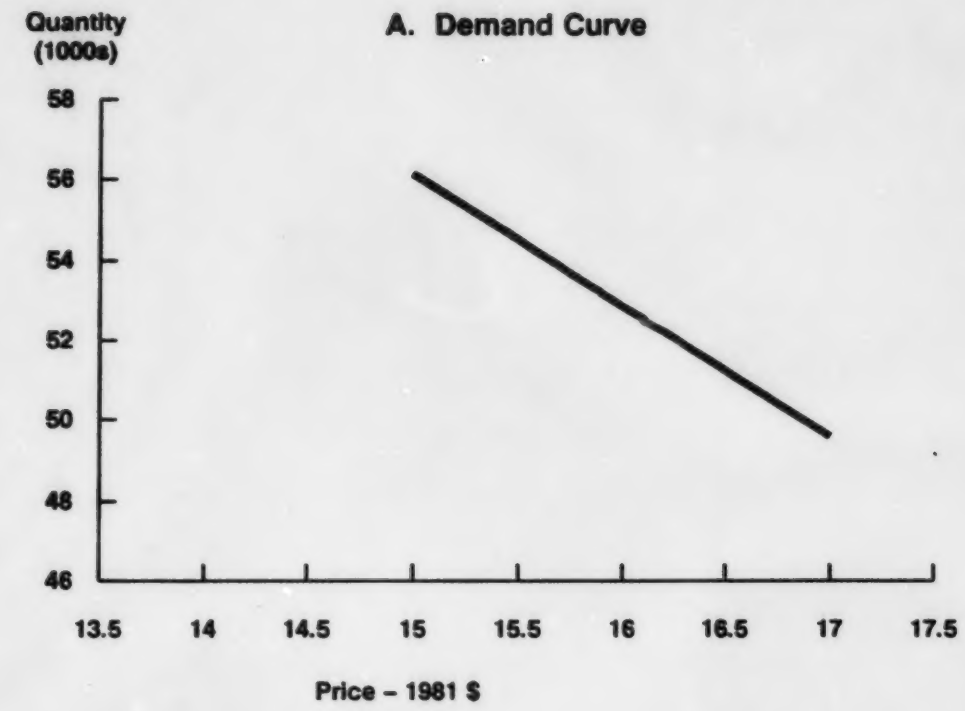
In summary, both these equations predict demand for migratory bird hunting licences. For example, the linear equation identifies that for every dollar the licence price increases and if all other variables remain constant, a decline of sales about 3 267 licences is expected. Conversely, for every additional 1000 waterfowl harvested, with all other variables constant, 32 additional licences will be sold in the following year. The next section identifies that with respect to revenue, both equations identify the same conclusion.

B. DETERMINATION OF REVENUE MAXIMIZING PRICE

The revenue maximizing price for migratory game bird licences was determined for 1986. This involved specifying a simple price/ quantity demand curve using the linear form specified in equation [3] and holding the non-price variables or demand shifters constant. The slope of the curve was equal to the regression coefficient of the price variable. The intercept was calculated by adjusting the regression equation intercept value. The 1986 values for HARVLAG, PONDS, PRECIP, and TREND were substituted into equation [2] and added to the intercept. Thus the 1986 simplified demand relationship with demand shifters held constant was:

$$NOLIC = 105.13 - 3.2665PRICE \quad [5].$$

This demand curve is plotted in Figure 3a by substituting various prices into the equation and calculating the quantity of licences demanded.



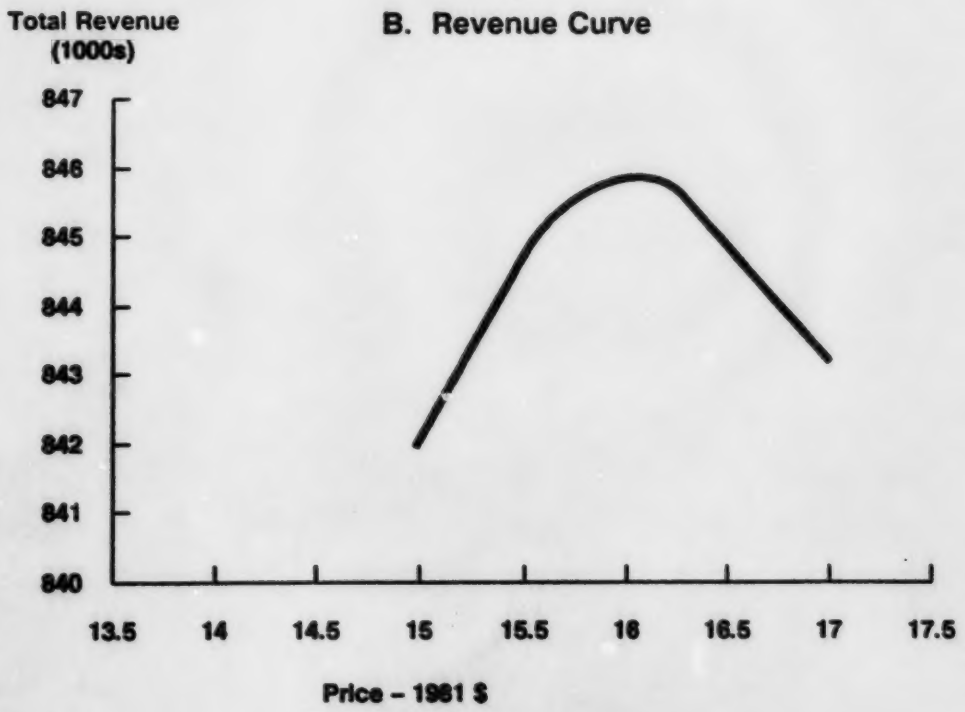


Figure 3. The Linear Demand Curve and Total Revenue Curve for Migratory Game Bird Hunting Licenses in Alberta.

The revenue generated by selling licences is derived from multiplying the number of licences demanded by their price. A total revenue curve can be generated by plotting various prices against appropriate revenues. Figure 3b shows a total revenue curve for the same range of prices used in plotting the demand curve.

The maximum of the total revenue curve indicates the price at which revenue is maximized under the demand equation specified in equation [5]. For 1986, this revenue maximizing price (in 1981 dollars) is about $16.10 with an approximate 95% confidence interval of $12.80 to $21.66. Inflating these to 1986 dollars yields a price of $20.62 with 95% confidence intervals of $16.40 to $27.75. The nominal or actual price of the required licences in 1986 was $23.50, which falls within the above confidence limits.

Performing a similar analysis with the semi-log form of the demand model (equation [4]) yields a different result. In this case, the revenue maximizing price in 1981 dollars is $20.28 with 95% confidence limits of $15.79 to $28.33. In 1986 dollars, this price becomes $25.98 and the confidence interval is $20.22 to $36.29. Once again, the actual 1986 price falls within the confidence limits.

C. EFFECT OF STABILIZED DUCK HUNTING REGULATIONS

The period 1979 to 1984 involved a program of stabilized hunting regulations. These regulations involved holding constant the allowable daily harvest of ducks during the period. The intent of this program was to control one aspect of the total mortality on ducks, and to

see if hunting had an important impact on the population size of birds. Although numerous investigators have since looked at the effect this program has on the birds, to the author's knowledge none have looked at the effect of the program on hunter participation.

The effect of this program on the demand for hunting licences was investigated with a dummy variable included in the model specified by the linear form of the demand equation [1]. A dummy variable is a binary variable which has a value of one or zero for each observation. Thus, in the demand equation the dummy variable had a value of 1 for each year the regulations were stabilized (1979-1984), and a value of 0 otherwise.

Upon inclusion of this dummy variable, the regression results indicated possible multicollinearity: PRECIP was the offending variable. This variable was deleted from the model and the OLS regression was performed again. The resulting equation was as follows:

$$\begin{array}{lcccccc} \text{NOLIC} & = 104.484 & - 3.192\text{PRICE} & + 0.037\text{HARVLAG} & - 0.006\text{PONDS} & - & \\ \text{(t statistics)} & (11.42) & (-7.44) & (6.62) & (-1.89) & & \\ & & 0.707\text{TREND} & + 4.533\text{STABREG} & & & \\ & & (-3.37) & (1.98) & & & [6]. \end{array}$$

This equation is highly significant with an F value of 34.65 ($P<0.0001$). All coefficients are significantly different than 0 at the 99% level except PONDS ($P<0.08$) and STABREG ($P<0.07$). The $\bar{R}^2$ is 0.90. The positive sign on the STABREG coefficient indicates that the stabilization program had a positive effect on demand for licences. A similar positive influence was found using the semi-log form of the demand equation (equation [2]).

DISCUSSION

This study has indicated that the demand for migratory waterfowl hunting permits is sensitive to changes in price. This result gives wildlife managers an idea of the impact that changing prices has on hunting participation and revenue. However, this is not a new finding. The British Columbia government studied the reasons for declining hunting licence sales and also concluded that the rising cost of licences, combined with the rising cost of living, were among the significant influential factors (Province of British Columbia 1987). Agencies in the United States have also been sensitive to this finding especially since much of their budgets are derived directly from hunting permit sale revenues.

A major deficiency in this study is the lack of inclusion of a variable describing the total cost of hunting in a given year. The price of a hunting permit is only a small part of this total cost. For example, the cost of owning and operating a motor vehicle has increased faster than for other goods and services during the 1980s (Jacquemot pers. comm.). When associated with hunting activity these costs may affect licence sales. However, it is important to note that no information exists as to whether these types of purchases are viewed negatively or positively by consumers. A 20% increase in the cost of ammunition for hunting may not be viewed as negatively as a 10% increase in the cost of a hunting permit. The fact that hunting licences are a source of revenue for the government may cause them to be viewed differently by consumers, despite their low cost. This is worth further

study.

Licence prices are usually influenced and set by political processes. It may be assumed by decision-makers that raising prices, by 50% for example, will not cause a change in participation, but will increase revenues by 50% (e.g. Young and Wrobel 1985). This study shows that this assumption is not necessarily correct. The study also shows how important prices can be in adjusting or influencing participation rates. This means that fee setting could become an actual management process or tool and not necessarily only a political decision. If the goal is to reduce hunting pressure for example, the licence price could be adjusted upwards. Licence fees could therefore be used along with bag limits and the length of the season to effectively manage the harvest of game species.

Revenue maximization, although not generally a specific concern of most Canadian wildlife management agencies, is one aspect of the economic background to hunting that can be investigated using consumer theory. In this study, the two mathematical forms of the demand equation gave somewhat different predictions of what the revenue maximizing price could be. The linear form identified that the actual 1986 price charged was somewhat high, although it did fall within the approximate 95% confidence interval. The semi-log form showed that the actual price and the revenue maximizing price were within about two dollars of each other, and the actual price also fell within the 95% confidence interval. Given this information, a conservative approach to maximizing revenue would be to not change the current fee structure in Alberta.

Price, however, was not the only variable that was significant in the regression analyses. The previous year's harvest of birds had a significant positive effect on licence sales. This was expected because

in other studies, previous hunting experience was found to influence hunter satisfaction (e.g. Filion and Parker 1984). Inclement fall weather was found to adversely affect licence sales. This was also expected. However, the fact that it was statistically significant may indicate that a significant number of waterfowl hunters wait until just before they hunt before buying waterfowl hunting licences. The May pond index also adversely affected demand. The reasons for this are unclear. One suggestion is that it could be related to the previous fall's precipitation. This implies the existence of autocorrelation, and is fruitful ground for future research.

The significant negative coefficient on the trend variable proves to be one of the most interesting findings. This variable reflects the effect of omitted variables such as tastes and preferences. Anderson et al. (1985) performed an analysis similar to this study for the state of Maine, and also found the trend variable to be negative. They hypothesized two possibilities: a shift in attitudes away from hunting, or a general decline in the quality of the hunting resource. They chose the former based upon previous studies. In Alberta, however, both could influence demand. Recent trends indicate a general decline in hunting in Alberta (Boxall and Smith 1986), while declining duck populations could also influence "quality" measures of hunting. It is unfortunate that the breeding season index used in this study as a measure of duck abundance was not significant. However, in the absence of better indicators of both "Alberta-born ducks" and ducks from other areas in the fall flight, it was the only choice available.

It was disappointing that other variables such as income, population, and various agricultural variables were not found to

influence demand significantly. Income, for example, should theoretically have a positive effect on demand. However, per capita Alberta income was used in this study and it may not reflect accurately the changes in hunter income in this province from 1968 to 1986. To investigate this possibility better measures of the income of hunters should be tried in future studies.

The effect of hunting regulations on demand was only briefly investigated in this study. The models determined that the stabilized duck hunting regulations program in effect from 1979 to 1984 had a positive influence on participation. However, this result could be related to the use of a dummy variable that may also have measured other factors that affected demand in those years. Fall precipitation seemed to be correlated with this variable. Perhaps drought conditions on the prairies were an important influence on fall precipitation during 1979-1984, and this was picked up by the dummy variable. However, it is noteworthy that the sign of the STABREG coefficient was positive. In the absence of other information to the contrary, it is suggested that the advertisement of the regulations stabilization program may have influenced hunter participation by demonstrating that management agencies were doing something about the declining duck populations. This suggestion is certainly worthy of future study.

SUMMARY

In summary, this paper presents some ideas for managers regarding the economic conditions surrounding waterfowl hunting in Alberta. It identifies the possible uses of economic theory in the analysis of revenue maximization and in the specification of variables that influence the demand for migratory game bird hunting. A number of issues and questions were raised relative to future socio-economic work surrounding hunting. It is suggested that these be investigated in future studies.

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